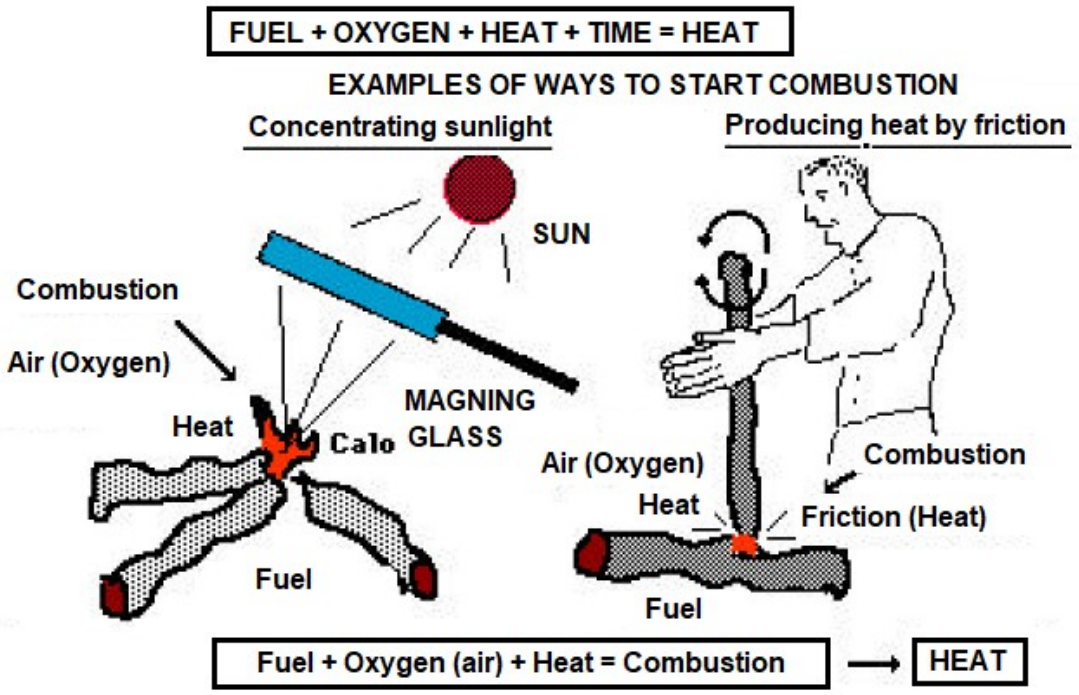
CHAPTER 3: The Fuel

3-Fuels and their combustion:

We will call fuels those products that we use to "burn" in boilers to produce heat, such as petroleum derivatives: heavy fuel oil, heating fuel oil, gas oil, LPG, piped gas; plant derivatives (cellulosic) such as: firewood, husks (rice, sunflower, etc.); fuels extracted from the subsoil in solid form such as coal (anthracite, lignite, bituminous coal, etc.) or gases such as: natural gas, gas produced artificially (coal-fired gasifiers, wood-fired gasifiers, etc.).

We see that we have solid, liquid, and gaseous fuels. Fuels are composed of elements that, when combined with oxygen in the air (rapid oxidation or combustion), produce heat, and elements that are indifferent to this oxygen (they do not react with oxygen, are inert, and are carried away with the hot gas or remain as ash).

For combustion to occur, the appropriate conditions must be met: a combustible element must be present, oxygen must come into contact with this element, and the chemical reaction (oxidation) must take place (that is, a catalyst or condition that facilitates this reaction is needed; in the case of boilers, it is the heat itself that allows this reaction to occur; in other cases, there may be an inducer of this initial oxidation (electric spark, friction, etc.) or a metal or metal oxide catalyst, etc., which then retains the generated heat).



A combustion time is also required, which varies according to the fuels and the conditions under which the combustion occurs.

We see that combustion requires three elements:

1- a fuel,

2- oxygen from the air

3- heat (to initiate the reaction).

To these conditions, we must add sufficient time for combustion to occur in a given space, and sufficient temperature to maintain it (if it cools down, the combustion will "go out").

The place where combustion occurs is called the hearth or combustion chamber, and combustion must be completed within this space.

Otherwise, we will see that for some reason, there was insufficient time or the conditions for complete combustion were not met; that is, partial combustion has occurred (some elements will exit the chimney unburned, meaning unoxidized or partially oxidized; this loss can be significant).

The elements that contribute heat in fuels are:

Carbon (C), Hydrogen (H), and Sulfur (S).

Carbon can bond with one oxygen atom (CO, called carbon monoxide) or with two oxygen atoms (CO2, called carbon dioxide). Relationship between atoms.

CO, or carbon monoxide, is a colorless and odorless gas. It is poisonous and its production as a result of combustion is undesirable, since the heat it produces is only 1/3 of what the same amount of carbon is capable of producing: 2,200 kcal per kg of carbon (8,700 BTU per pound of carbon) would be only 1/3 of 7,833 kcal per kg of carbon (14,500 BTU per pound of carbon burned).

This same CO, or carbon monoxide, can also be supplied as fuel (as in gas generators), burning it and obtaining the remaining heat from its complete oxidation.

Carbon dioxide (CO2) is a colorless and odorless gas. It is the desired product of carbon combustion found in chimney flue gases, as it releases the maximum amount of heat in this state (7,833 kcal per kg of carbon, 14,500 BTU per pound of carbon).

CO2 is used to fizz carbonated beverages and to extinguish fires with pitchers (it is in a liquid state due to the pressure inside the pitcher, and upon release, it transforms into a cold gas that displaces the air—oxygen—extinguishing the fire).

Carbon dioxide (CO2) can be harmful to health (even though it's a gas we exhale) because it displaces air from the space it's in, being heavier than air. This is especially important to keep in mind when cleaning wine vats in cellars, as they are often full of this gas and must be ventilated before entering (asphyxiation can be fatal).

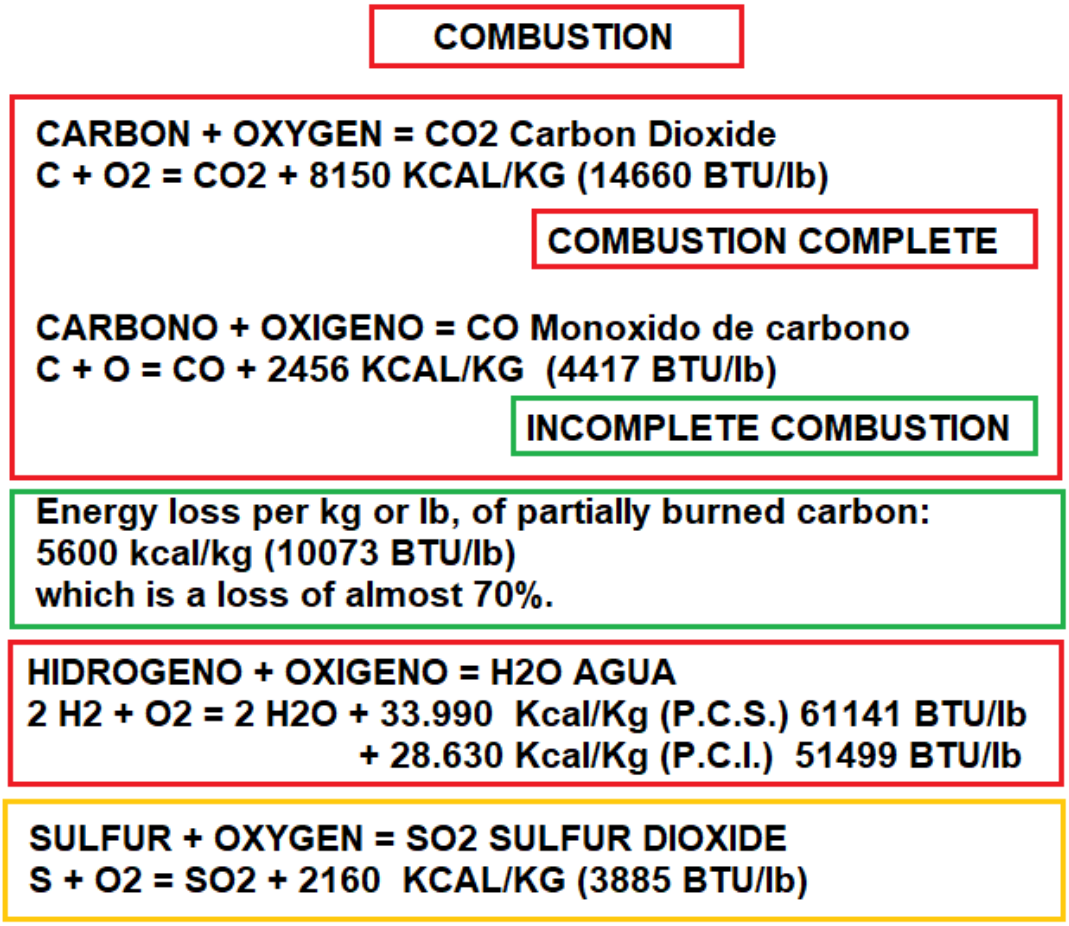
Hydrogen (H) combined with oxygen (O) produces water (H2O) (which will exit the chimney as water vapor) and heat (33,990 kcal per kg of H2 if we consider that the water formed condenses at 0°C; in imperial units, 61,127 BTU per pound of H2).

As we can see, it produces a large amount of heat per kg of hydrogen. Hydrogen torches produce high temperatures. It is used as rocket fuel, is highly explosive when mixed with air, etc.

Sulfur (S), when combined with oxygen (O), produces sulfur dioxide (SO2), a strong-smelling, poisonous gas that also releases heat (2165 kcal per kg of S).

This is an undesirable element in fuels because it produces little heat, and in the presence of water, it transforms into a corrosive acid: sulfuric acid (H2SO4), the same acid used in car batteries.

This acid typically attacks the iron in chimneys and recuperators (air heaters and economizers). Its concentration is highest in some types of coal and in some heavy fuel oils.


COMBUSTION
CARBON + OXYGEN = CO2 Carbon Dioxide
C + O2 = CO2 + 8150 KCAL/KG (14660 BTU/lb)
COMBUSTION COMPLETE
CARBONO + OXIGENO = CO Monoxido de carbono
C + O = CO + 2456 KCAL/KG (4417 BTU/lb)
INCOMPLETE COMBUSTION
Energy loss per kg or lb, of partially burned carbon:
5600 kcal/kg (10073 BTU/lb)
which is a loss of almost 70%.
HIDROGENO + OXIGENO = H2O AGUA
2 H2 + O2 = 2 H2O + 33.990 Kcal/Kg (P.C.S.) 61141 BTU/lb
+ 28.630 Kcal/Kg (P.C.I.) 51499 BTU/lb
SULFUR + OXYGEN = SO2 SULFUR DIOXIDE
S + O2 = SO2 + 2160 KCAL/KG (3885 BTU/lb)

There are other elements in fuels that do not undergo combustion, remaining in the home (ashes: silica, calcium, sodium, magnesium, etc.) or escaping through the chimney as ash, gases, or vapors (oxygen, nitrogen, water, etc.), absorbing some of the heat generated.

In the case of water, this absorbed heat is very significant, as the latent heat of vaporization of water is very high.

The water content of firewood (moisture) causes significant heat loss. For every kg of water (H_2O), approximately 600 kcal/kg (1080 BTU/lb) are lost. In fuels containing hydrogen (H), the water formed during combustion also absorbs heat. (However, H_2 releases a great deal of heat when it oxidizes, and for every 1 kg of H_2O, 9 kg of H_2O are formed; 1 lb of H_2O generates 9 lbs of water (H_2O).

The hydrogen-to-carbon ratio (H/C, the two elements that produce heat, not considering sulfur, which produces little heat and is undesirable) defines, primarily among liquid fuels, their combustion reaction. In other words, if one fuel oil has a higher hydrogen-to-carbon content compared to another (all other lighter fuels have this ratio: heating oil, diesel, gas oil, etc.), it will combust more easily and have a lower risk of soot formation.

This seems logical, given hydrogen's high heat output and high combustion rate, which improves the combustion of carbon, which is inherently slower (but the incandescent carbon also has a catalytic effect on combustion, accelerating it and shortening the flame length by increasing its combustion rate—a problem that arises in gaseous fuels with low carbon content and therefore low luminosity, where the flame length will be longer).

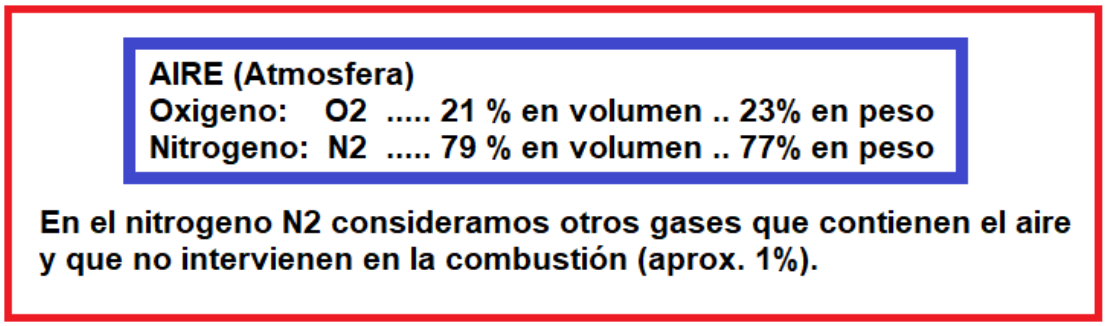
From what has been said above, we can see that the amount of heat that 1 kg of fuel can produce depends on whether we consider that water, which is present in the fuel or formed during combustion, to be in the form of steam (steam that goes up the chimney) or in the form of water (we cool the flue gases to 0°C - this is practically impossible).

This heat per kg of fuel is called the calorific value of the fuel. The Higher Heating Value (HHV) is calculated if we consider the water brought in and formed at 0°C (condensed water and combustion gases at 0°C), and the Lower Heating Value (LHV) is calculated if we consider the heat remaining after evaporating all the water brought in and formed (evaporated water, combustion gases, and steam at 0°C).

LHV = HHV - kg of water x 600 kcal/kg (practical value of heat of vaporization) or x 1079 BTU/lb

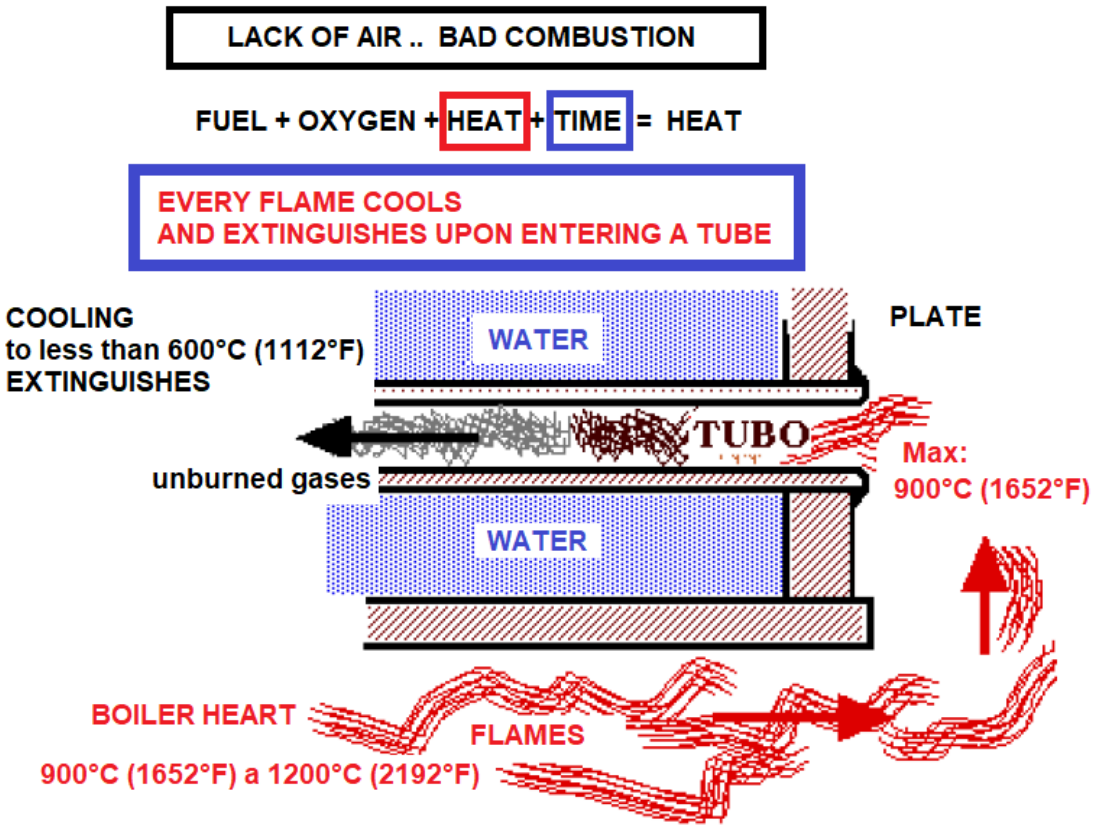
The air we use for combustion is composed of oxygen (21% by volume) and nitrogen (79% by volume, a gas that does not participate in combustion, but which, when heated, carries heat up the chimney). It also contains other gases of

little numerical significance that do not participate in combustion (argon, neon, helium, etc.).


AIRE (Atmosfera)
Oxigeno: O2 ..... 21 % en volumen .. 23% en peso
Nitrogeno: N2 ..... 79 % en volumen .. 77% en peso
En el nitrogeno N2 consideramos otros gases que contienen el aire y que no intervienen en la combustión (aprox. 1%).

Since the Earth's atmosphere at sea level maintains this oxygen-to-nitrogen ratio (there are other gases in very small quantities), and since each fuel contains specific amounts of carbon, hydrogen, sulfur, etc., the combustion product (flue gases) has a ratio specific to each fuel. This ratio is unique for each combustion condition. (See the Ostwald diagrams in later chapters.)

To achieve complete combustion, we must ensure that every oxygen (O2) molecule comes into contact with every fuel molecule and that the temperature is sufficient for combustion to occur (oxidation, the fusion of oxygen atoms with hydrogen, carbon, and sulfur atoms). To achieve this, we will need more air than the **minimum or stoichiometric** amount required.


LACK OF AIR .. BAD COMBUSTION
FUEL + OXYGEN + HEAT + TIME = HEAT
EVERY FLAME COOLS
AND EXTINGUISHES UPON ENTERING A TUBE
COOLING
to less than 600°C (1112°F)
EXTINGUISHES
WATER
PLATE
TUBO
unburned gases
Max:
900°C (1652°F)
WATER
BOILER HEART
FLAMES
900°C (1652°F) a 1200°C (2192°F)

This excess air (called **"excess air"**) is a necessary evil, since any excess air we heat will escape through the chimney, carrying away heat unnecessarily.

Therefore, we must try to ensure that the fuel and air mix as intimately as possible, adding only excess air **to achieve complete combustion** (so that no fuel remains unburned), but this excess should not be too high, as it carries heat away through the chimney.

Since the composition of flue gases varies depending on the fuel, measuring their composition allows us to determine the amount of excess air being used.

For example, if we were to burn fuel oil and measure the oxygen in the flue gases, we would have three scenarios:

1- **No oxygen (insufficient air):** incomplete combustion (generally black smoke) or complete combustion (practically impossible, as this would represent stoichiometric air).

2- **A certain percentage of oxygen and no carbon monoxide (excess air):** combustion can be good or poor (smoke, soot, due to insufficient mixture or temperature).

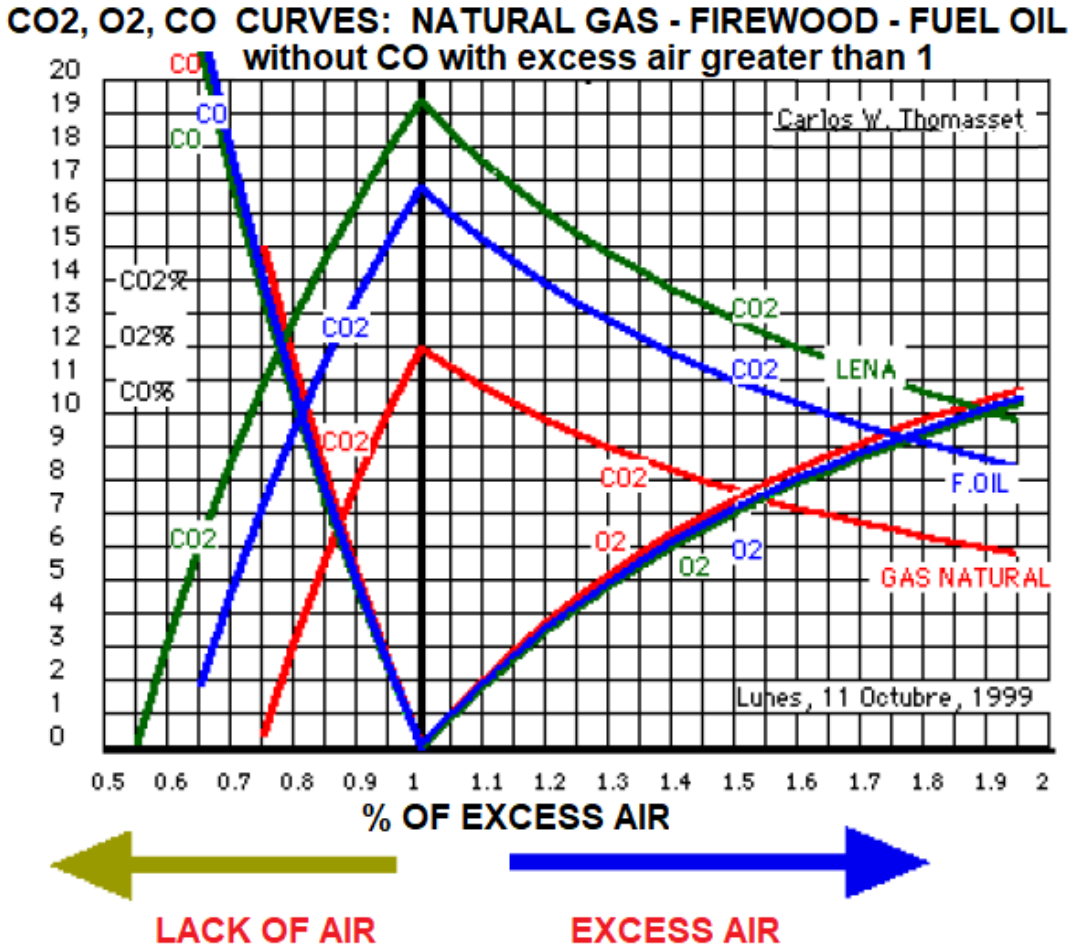
3- **A certain percentage of oxygen and carbon monoxide: poor combustion** (incomplete combustion, generally present smoke, soot, etc.).

FUEL OIL SMOKE

The presence of smoke in chimneys was always a helpful indicator of combustion quality, but this is now entirely insufficient, since the burning of gases and wood (biomass) does not produce the smoke in the chimney that can serve as a guide for combustion.

Burning fuel oil (heavy and light) is a good indicator (as is coal). The gases and combustion of cellulose fuels have led to the need for combustion control to be carried out using instruments, both to determine the necessary excess air and to detect unburned gases (which are a waste of energy and a significant source of environmental pollution).

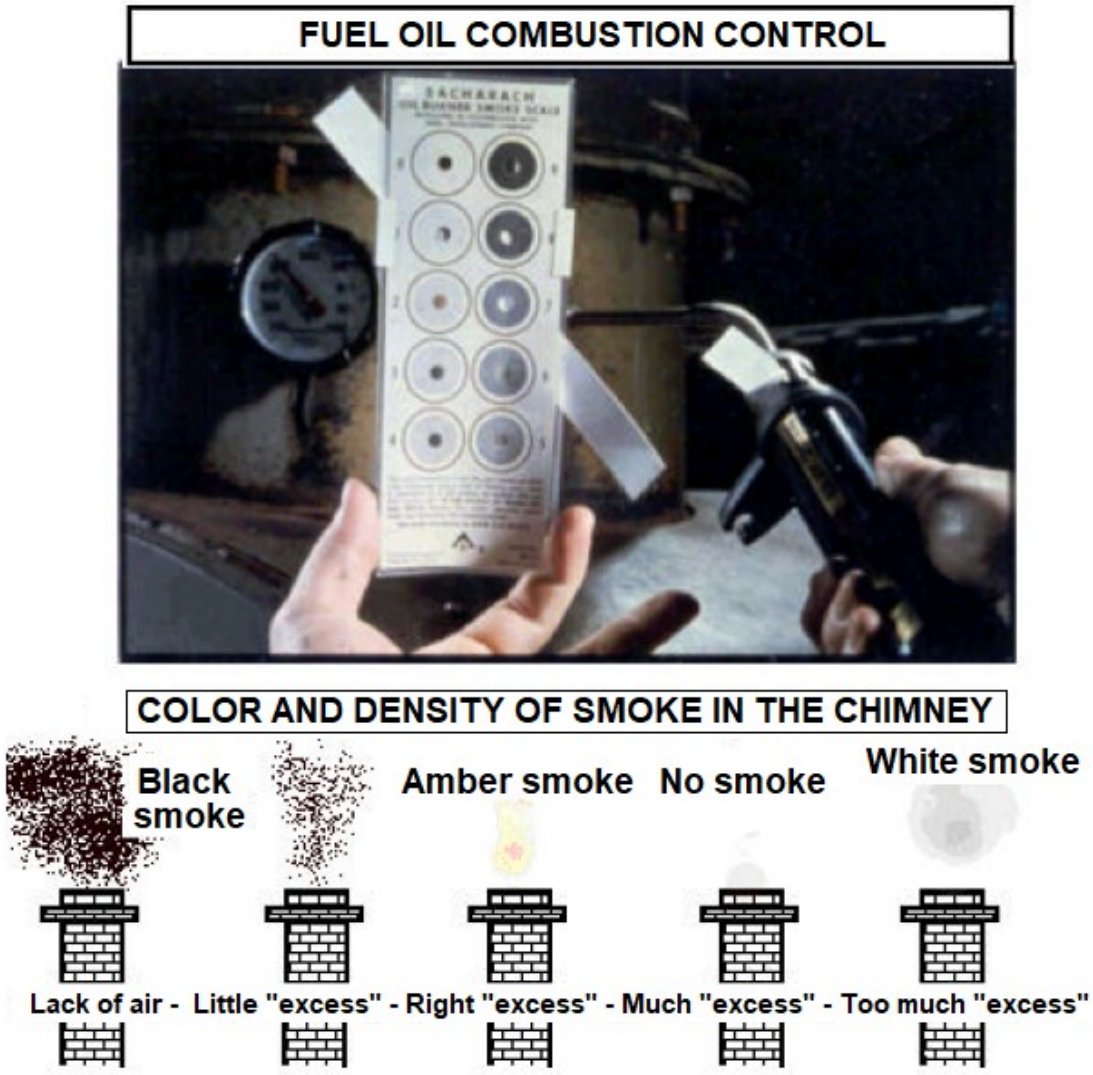
We will see that the color and shape of the flame is a way to determine the combustion result, but this varies from one fuel to another, with fuel oil being the most noticeable.



A certain amount of excess air is always needed for complete (or near-complete) combustion.

The greater this excess air, the greater the fuel loss.

Each fuel and burner type has a minimum excess air requirement, as unburned gases or soot appear below this level.


FUEL OIL COMBUSTION CONTROL
COLOR AND DENSITY OF SMOKE IN THE CHIMNEY
Black smoke
Amber smoke
No smoke
White smoke
Lack of air - Little "excess" - Right "excess" - Much "excess" - Too much "excess"

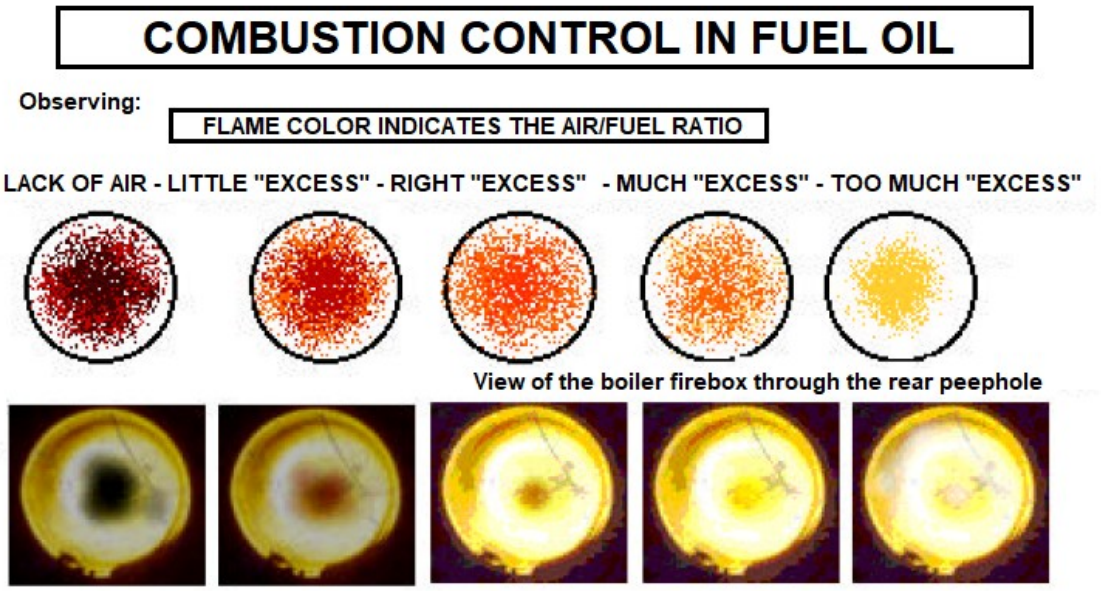
Soot:

Carbon in the form of coal particles, usually accompanied by smoke. In case 2 (no smoke and excess oxygen), we can determine the excess air without needing other values, since each excess of oxygen corresponds to an excess of air. Knowing the fuel composition will make the

measurement more precise. See Ostwald diagrams next chapters.

The problem is that some fuels do not produce visible smoke or soot (rather, the incompletely burned carbon is released as CO - carbon monoxide - or other organic compounds). These fuels, which are difficult to soothe, include firewood, natural gas, and petroleum-derived or artificial gases.

In fuel oil and coal, smoke control, both visually and with instruments, shows us a series of combustion problems, including a lack of “excess air” (there should be a little more than the minimum air required, depending on the type of fuel and the type of burner), but the presence of smoke is not only due to a lack of air, but also to other problems, such as atomization, the temperature of the fuel, the furnace, the degree of combustion, burner failures or failures of the air and fuel mixing system, etc.


COMBUSTION CONTROL IN FUEL OIL
Observing:
FLAME COLOR INDICATES THE AIR/FUEL RATIO
LACK OF AIR - LITTLE "EXCESS" - RIGHT "EXCESS" - MUCH "EXCESS" - TOO MUCH "EXCESS"
View of the boiler firebox through the rear peephole

The color and shape of the flame when burning fuel oil gives us a clear indication of what is happening with combustion. This is complemented by observing the smoke, but measuring the flue gases (CO2, O2, and CO) provides a better way to diagnose the combustion process.

The other gas we can measure in the flue, and whose percentage indicates excess air, is carbon dioxide (CO2).

If the amount of air were the minimum necessary (stoichiometric air), there would be a maximum CO2 content characteristic of each fuel:

approximately 16% on a dry basis for heavy fuel oil,

20% for cellulosic fuels,

11.5% for natural gas, etc.

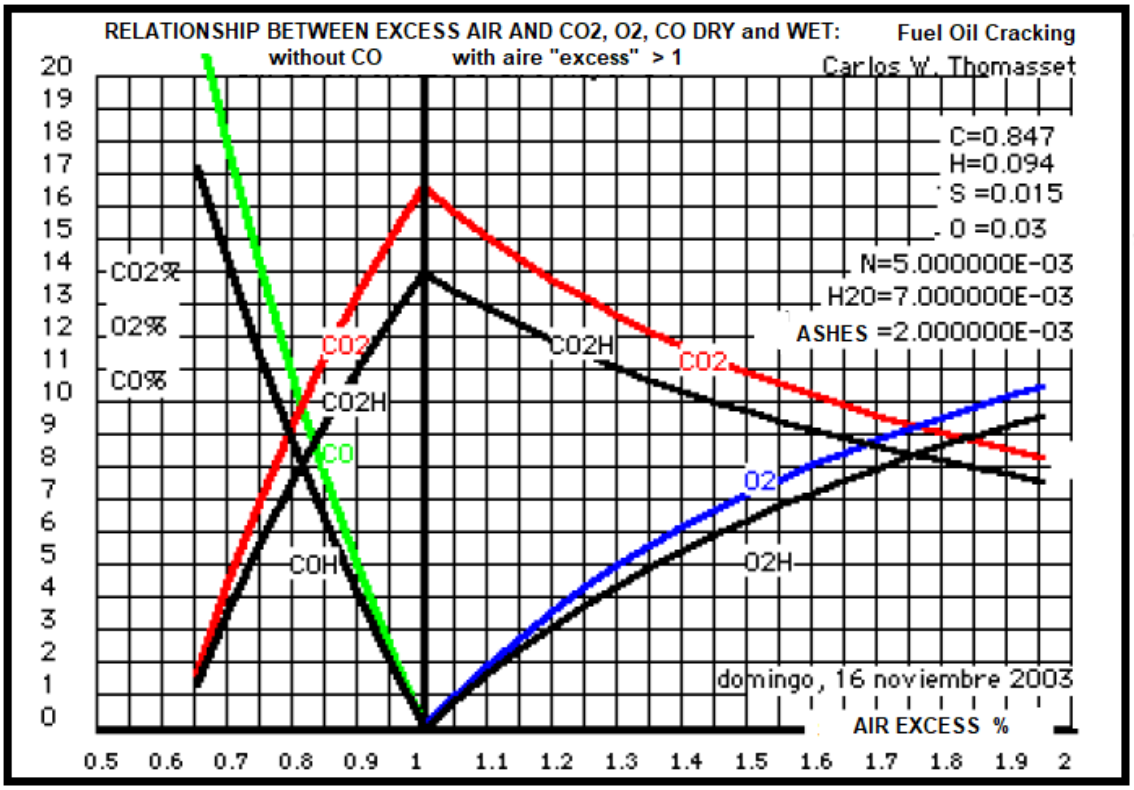
As the excess air increases, the percentage of CO2 in the gases decreases because the gases expand due to the increased air content. (This does not mean that less CO2 is produced, but rather that it is diluted).

If we determine the percentage of excess air based solely on the percentage of CO2, for the result to be accurate, there must be no presence of carbon monoxide.

When we measure the percentage of carbon monoxide (CO) and the percentages of oxygen (O2) and carbon dioxide (CO2), we can correlate the three measurements and determine the excess air without needing to know the fuel composition. (Case of ORSAT, detailed in Chapter 5).

Measuring flue chimney gases is crucial, as it provides information on combustion quality and excess air. Both of these represent energy losses that must be minimized in the boiler.

The % measurement of flue gases may be referred to on a dry basis (i.e., condensing the moisture of the flue gases - the most common measurement) or on a wet basis (i.e., taking into account the moisture of the flue gases).



The easiest measurement to perform is that of carbon dioxide (CO2), for example, with the FYRITE device (Chapter 5), which works by absorbing the gas in potassium hydroxide.

When we want to measure all three gases (CO2, CO, and O2), the simplest chemical absorption device is the ORSAT (Chapter 5).

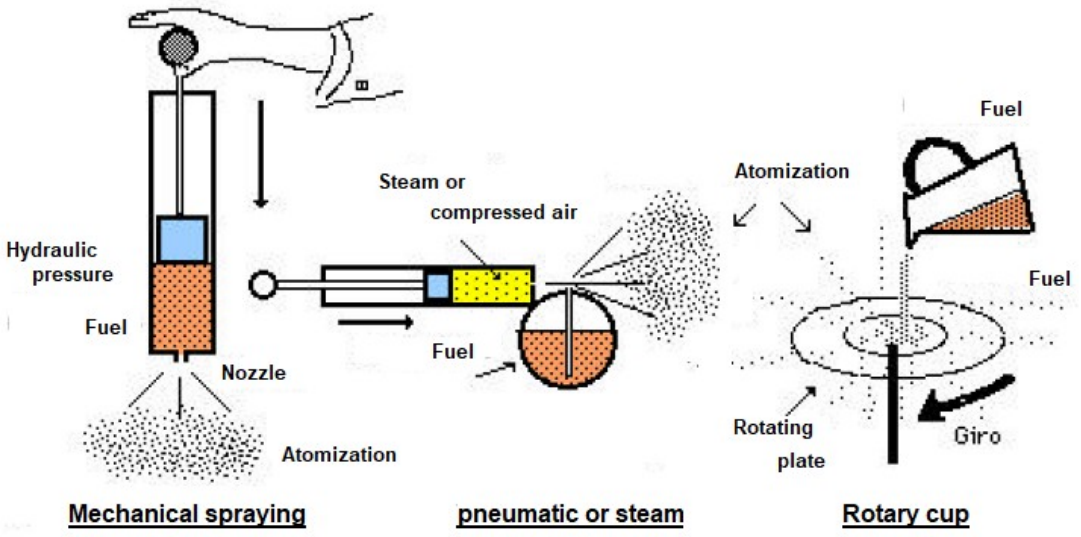
Afterward, measurements can be taken with electrically or electronically operated equipment: electrochemical cells (O2), catalytic cells (CO), dissipation bridges (CO2), etc.

Not only carbon monoxide (CO) can be present as unburned gas in flue gases; other gases (hydrogen, H2, or volatile organic compounds) may also be present, but for practical purposes, they are all treated as CO. Generally, when CO is detected, these combustible gases may also be present.

We see that fuels are solid, liquid, or gaseous. To achieve good combustion, we need the fuels and air to mix intimately. The best way to do this is to gasify (volatilize) them: gaseous fuels are mixed directly, liquid fuels are

pulverized (atomized), and solid fuels are heated in pieces (primary combustion) so that they volatilize.

But it must be clear that, even though the fuel is a gas, no matter how much it is mixed with air, there must be sufficient temperature (heat) and time for its complete combustion (oxidation) to take place.

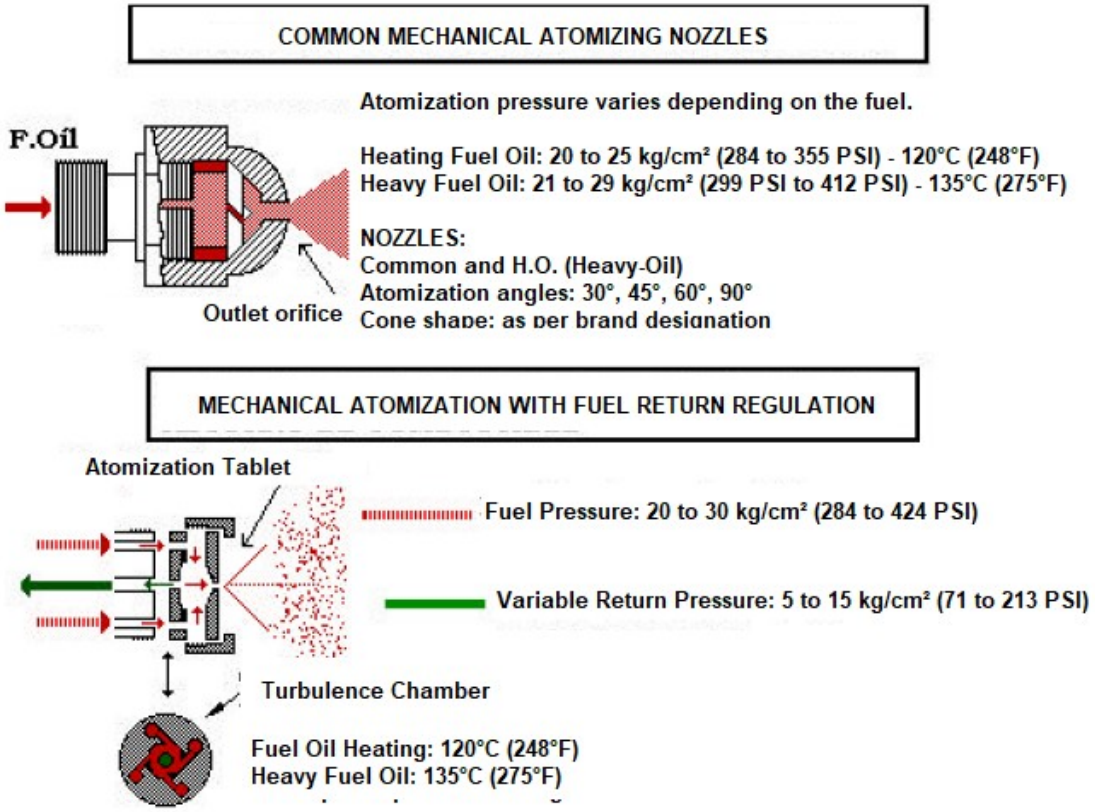


Therefore, we will have: liquid fuels will be atomized in burners that use the following methods: steam-assisted atomization (using steam to propel the fuel in the form of very small droplets), pneumatic atomization (using pressurized air for the same purpose), mechanical atomization (using high discharge pressures in orifices called nozzles, tips, or nozzles, whose internal shape allows for the formation of a very fine spray upon release), and rotary cup atomization (atomizing using centrifugal force).

Light fuels such as diesel and gas oil are typically used with steam-assisted or mechanical atomization burners as they come (unheated).

Because heavy and medium-heavy fuel oils have difficulty flowing through pipes due to their thick, pasty consistency (high viscosity) when cold, they need to be heated to different temperatures to facilitate their transport through the pipes and pumps, as well as to atomize them. This heating depends on the type of fuel oil and the type of pump, pipes, and burner being used.

This heating can be done with steam heaters or electric heaters (or both systems alternately: electric to start when there is no steam, and steam once the boiler has begun generating it).


COMMON MECHANICAL ATOMIZING NOZZLES
Atomization pressure varies depending on the fuel.
F.Oil
Heating Fuel Oil: 20 to 25 kg/cm² (284 to 355 PSI) - 120°C (248°F)
Heavy Fuel Oil: 21 to 29 kg/cm² (299 PSI to 412 PSI) - 135°C (275°F)
NOZZLES:
Common and H.O. (Heavy-Oil)
Atomization angles: 30°, 45°, 60°, 90°
Cone shape: as per brand designation
Outlet orifice
MECHANICAL ATOMIZATION WITH FUEL RETURN REGULATION
Atomization Tablet
Fuel Pressure: 20 to 30 kg/cm² (284 to 424 PSI)
Variable Return Pressure: 5 to 15 kg/cm² (71 to 213 PSI)
Turbulence Chamber
Fuel Oil Heating: 120°C (248°F)
Heavy Fuel Oil: 135°C (275°F)

Thus, for heavy fuel oil, we will see that to move it with pumps (generally of the positive displacement gear type), it is necessary to heat it to 60°C to achieve pumping without stressing the pipes and pumps (reducing its viscosity), and that to use it in the different burners, we will have to heat it to:

- For mechanical atomization, to more than 120°C (248°F), and even more in modern direct-start spark burners, around 145°C (293°F);

- In air atomization burners, it will also be heated to these temperatures (since air does not add heat when atomizing it, but rather cools it);

- In steam atomization burners, it will be heated to at least 85°C (185°F) (since steam adds heat, but it can be preheated to 110°C (230°F)). -and those with a rotary cup at least 85°C (185°F) and not much higher (since if it gets too hot it will "slide" on the cup, preventing it from being "sprayed" in droplets).

Heating F.Oil should be heated less because it has a lower "viscosity" than heavy F.Oil at the same temperature, around 120°C (248°F).

* Viscosity: is a measure that allows you to compare the work required to make a liquid flow or pass through a pipe or restriction. Generally, liquids decrease in viscosity at higher temperatures. There are several ways to express it numerically; generally, it is the time it takes for a certain quantity of liquid at a given temperature to pass through an orifice.

All fuel heated in tanks produces gases that are explosive or highly flammable; therefore, an appropriate heating system must be in place (with gas venting that discharges to non-contaminating or confined areas).

Excessive temperature causes fouling in the lines and vapor "plugs" that hinder pumping (loss of pump suction). Similarly, the presence of water causes atomization and combustion problems.

Regardless of the fuel used: before ignition, a purge with air (using maximum air pressure, for a time that depends on the type of fuel) must be performed to remove the mixture of combustible gases that may form in the combustion chamber (remnants of fuel that volatilize). Ignition can be violent due to the mixture of these gases and the insufficient air available for ignition, producing a combustion chamber explosion, which, depending on the type of boiler, can be highly dangerous.

Every boiler must be "ventilated or purged with air" before lighting its burners or fires, and every time ignition is attempted, even if the first attempt fails.

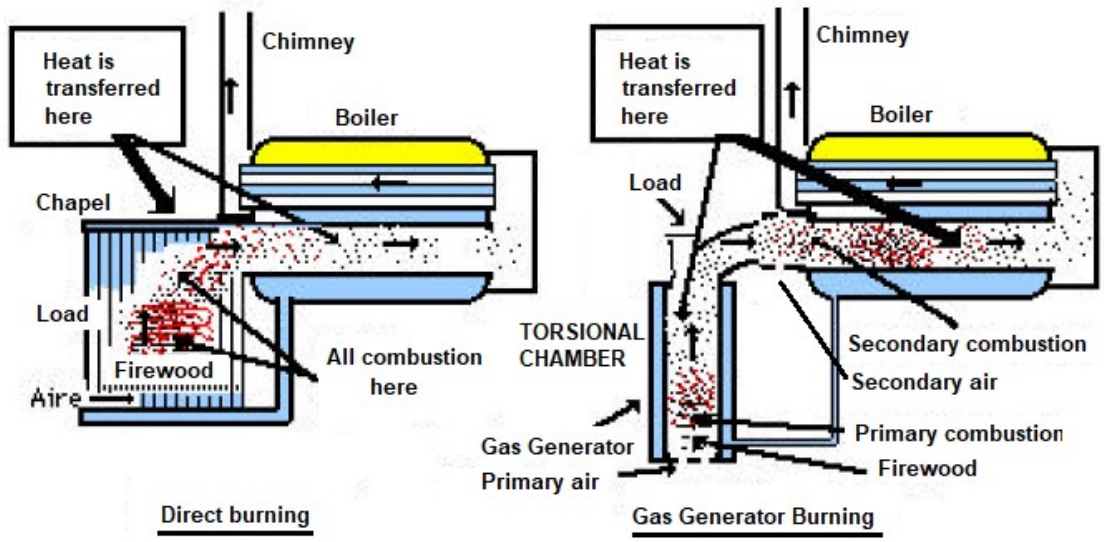
We will see that automatic burners will have this step included in their starting system.

In many situations, an auxiliary fuel will be necessary to ignite the main fuel: this could be a small gas burner (usually automatic), a manual gas burner, or a kerosene or diesel fuel wick.

In the case of wood, a small fire can be started with rags soaked in medium-weight fuel (with the firebox cool and ventilated).

All these operations must be carefully planned to avoid an accident (the auxiliary flame should be lit after purging with air and always before the main fuel).

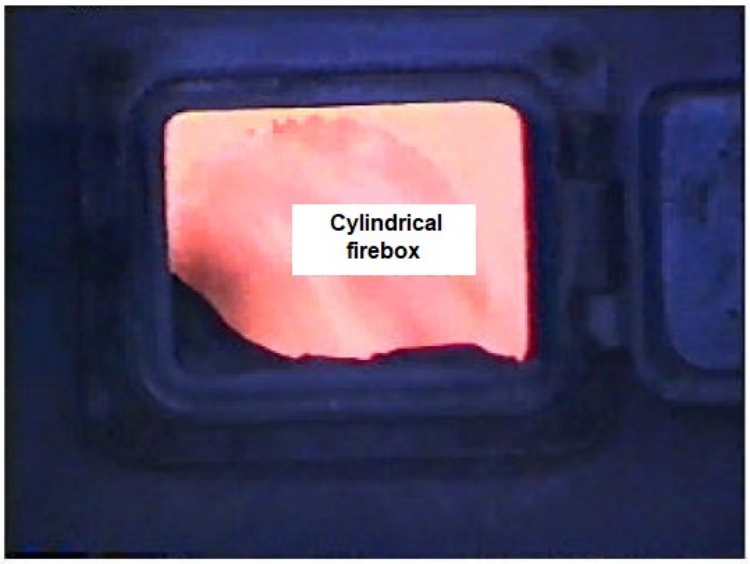
Do not attempt to ignite using the heat from the firebox refractory material; if there is no pilot light, there is a risk of explosion.



Wood combustion systems can be summarized in the following classifications: direct combustion and gas generator (torsional chamber).

In direct combustion, as the name suggests, combustion occurs completely within a combustion chamber, using high-temperature direct radiation. This allows for the combustion of virtually all imaginable fuels (wood and husks – rice, sunflower, nuts, etc., of all sizes: from small to large: from wood chips to long logs).

WOOD BURNING (EUCALYPTUS)
DIRECT FLAME VIEWED THROUGH THE PEEPHOLE



The combustion chamber where complete combustion takes place is generally a water-cooled structure (water-tube – called a "chapel" due to its shape). Its vaporization rate is very high compared to the boiler body itself (over 40%), giving the boiler excellent efficiency.

In gasifier combustion, partial combustion (gasification) occurs in a combustion chamber with insufficient air (producing a large amount of CO; this first chamber is cooled by water from the same boiler). A second combustion then takes place in another chamber (generally inside the boiler or main combustion chamber—primarily using convective and conductive heat, as the flame is less luminous).

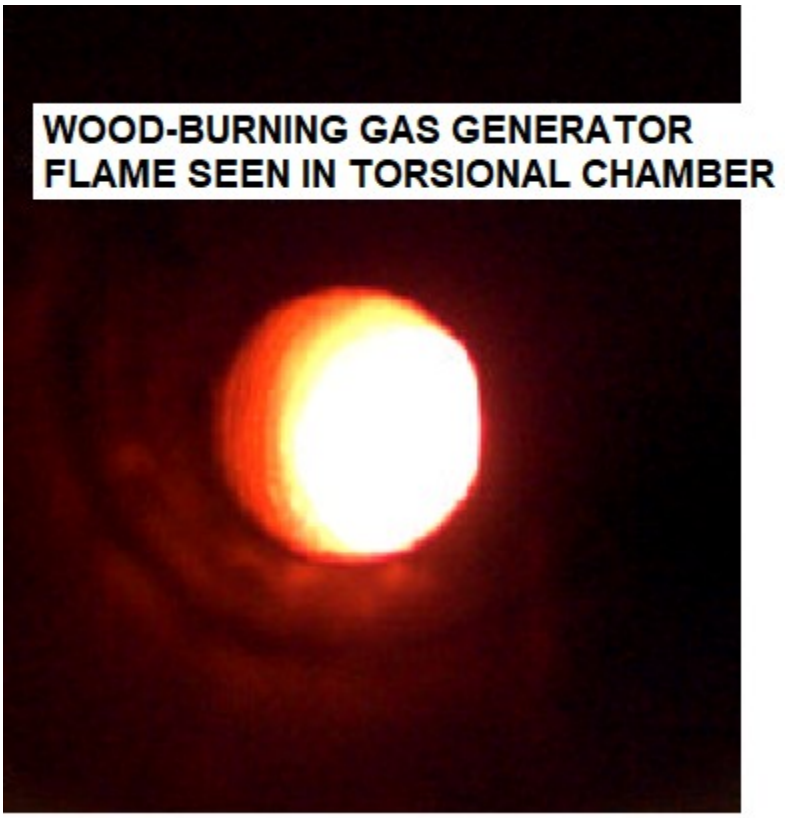
The fuel typically tolerates large wood chips or short logs; not all fuels can be burned indiscriminately (it is less tolerant of high moisture content).

In gasifier combustion, only a minimal portion of the combustion occurs, resulting in very low heat production (as we saw, CO formation is only 1/3 of the total heat that carbon can produce). Heat transfer is low in gasifier combustion, occurring primarily in the boiler's combustion chamber (i.e., during the second combustion, making it crucial that this combustion is complete before the fuel enters the tubes).

Both systems maintain a fuel charge level, and their combustion is regulated by adjusting the primary, secondary, and other air valves.

If combustion needs to be stopped momentarily, the air valves will be completely closed.

However, caution must be exercised when restarting combustion in the case of the gas generator, which will require a pilot light (in some cases) because the secondary combustion needs to be reignited (otherwise, backfires may occur). In other systems, the primary flame is extended.



Combustion is controlled through the rear sight glass by regulating the air intake through the torsional chamber.

A bluish, short flame should be visible, ideally with automatic oxygen control via a zirconium oxide cell.

Undesirable elements in fuels:

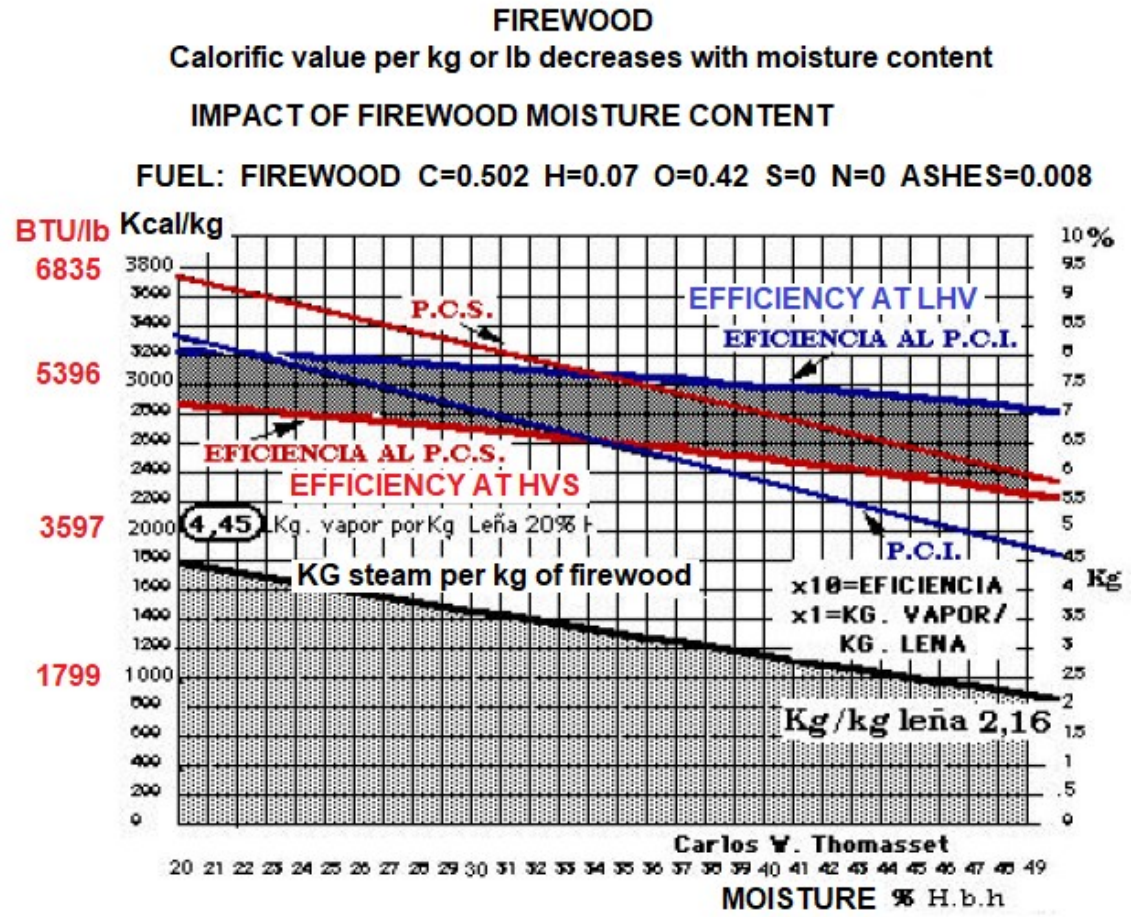
Any elements that could impair burner performance or combustion should be avoided.

Water in liquid and gaseous fuels, or "moisture in solid fuels," must be removed before reaching the burner. In the case of firewood, it should be as dry as possible, as these not only cause energy losses but can also lead to poor atomization in liquid and gas burners (even causing the burner to shut off or making it difficult to light).

Although a very small amount of water in the fuel can promote combustion—less than 1% in a complete emulsion—it is said to act as a catalyst.

In the case of firewood (eucalyptus and other biomass), the presence of excess water not only causes losses through evaporation, but also makes combustion more difficult to complete. This leads to premature fouling of the boiler's heat transfer surfaces, resulting not only in heat loss through the chimney but also in hindering the passage of gases. This, in turn, causes a lack of draft (the excess air is drawn down when, under these circumstances, the high humidity necessitates working with more excess air).

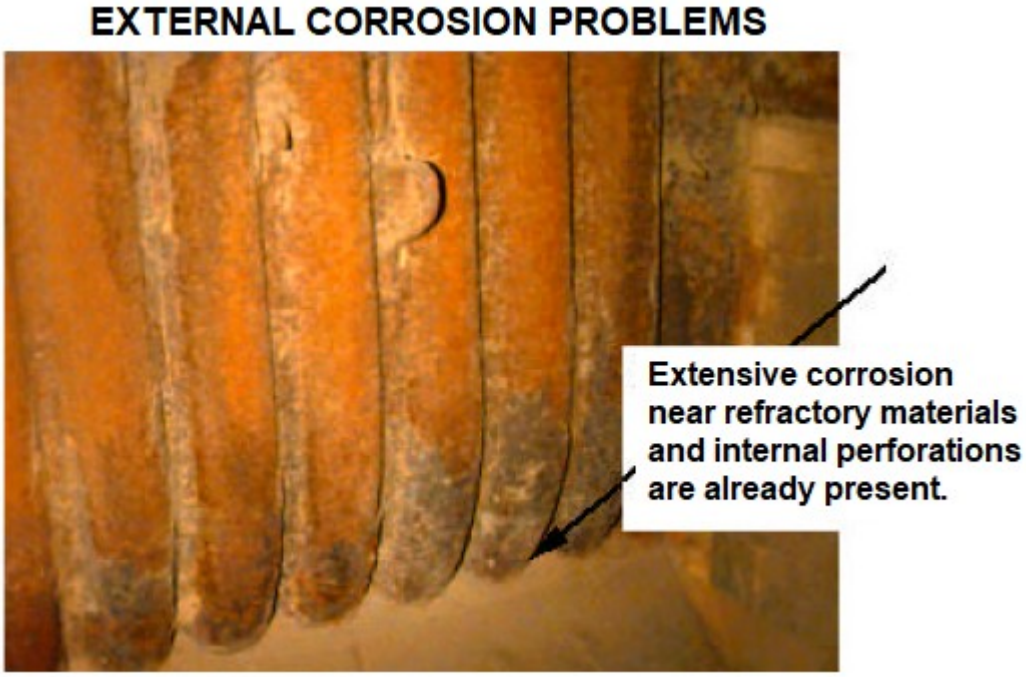
Although no smoke is visible from the chimney, there is a significant loss of unburned gases. These gases not only contribute to ash accumulation on the tube surfaces but are also pollutants (not only CO, but also a variety of other undesirable organic compounds, representing unused heat that contaminates the atmosphere).



Sulfur contributes very little heat and is highly corrosive; it should be avoided whenever possible (its corrosion can be very significant in the boiler, occurring in cold areas such as heat recovery units, economizers, and air heaters, or in hot areas such as superheaters—in this case, it acts due to the vanadium naturally present in fuel oil).

This sulfur, combined with the moisture in the fuel plus the water produced when burning the hydrogen in the fuel, forms sulfur dioxide (which, when catalyzed, forms sulfuric acid, a highly corrosive element when operating below the dew point of the gases, approximately 180°C (356°F) for fuel oil).

This corrosion causes significant damage to economizers, air heaters, and certain cold parts of the boiler. Fuel oil, coal, and rice husks contain sulfur in varying proportions.


EXTERNAL CORROSION PROBLEMS
Extensive corrosion near refractory materials and internal perforations are already present.

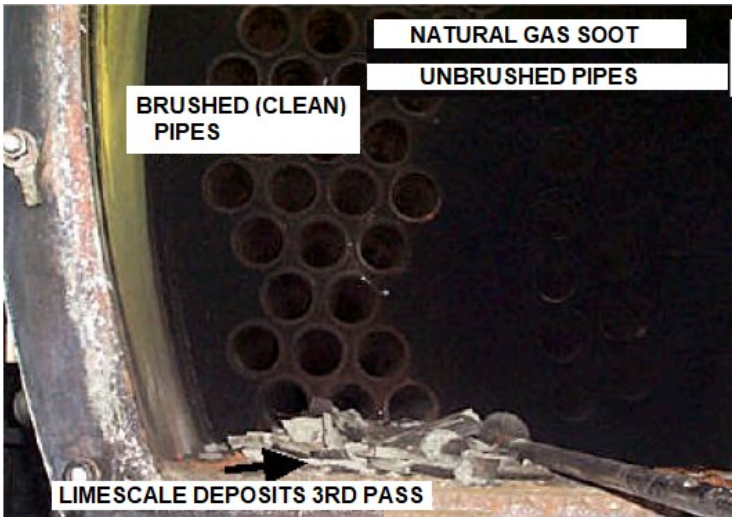
However, while sulfur appears to be the major corrosion problem in the combustion chamber of boilers (especially in cold areas, under refractory linings, etc.), cellulosic fuels (firewood) and gases can also be corrosive when combustion is incomplete.

Firewood with high moisture content or gases (natural gas, bottled gas, etc.) with incomplete combustion (lack of air,

low combustion temperature, poor air-fuel mixture, etc.) result in acidic combustion (due to organic compounds), such as pyroligneous acids, which attack the metal in cold areas: under refractory linings, smoke boxes, echo chambers, air heaters, etc. This often surpasses the corrosive effect of sulfur, which we tend to be more careful about.

Some boilers have lost metal thickness on the flue gas side within just a few years, rendering them unusable due to the thinning of the tube walls. Sludge and sand in liquid fuels cause wear and contamination problems.

Installing filters and ensuring the fuel inlets are properly located allows for cleaning (settling tanks for water and sludge that are regularly drained). In gases, if they are not properly treated, sulfur compounds, carryover deposits, and even soot can occur (something no one imagines, but soot is produced if there is insufficient air, poor gas-air mixing, low temperature, etc.).



Fuel Handling:

Gaseous fuels are very dangerous, and their handling is subject to very strict regulations.

All handling of liquid fuels must be done according to their "hazard," that is, whether they are easily "flammable" (explosive when mixed with air or easily ignitable; this is

measured by the **"Flash Point"** test: the temperature at which they ignite in air upon contact with a flame) or whether they can easily sustain combustion (this is measured by the **"Fire Point"** test: the temperature at which the fuel, once ignited, is capable of continuously burning on its own in contact with air).

Thus, we will see that the order of care in handling them is from Gas Oil to Diesel Oil, then Heating Oil, and finally Heavy Fuel Oil (taking care never to put gasoline or solvents in a tank containing fuel).

In the case of firewood, if "piles" or "heaps" of finely chopped wood ("chips") are established, when accumulated with moisture, if it is left for a long time it can cause "burning" or combustion by fermentation, which, although it is a slow combustion at first, can degenerate into a fire.

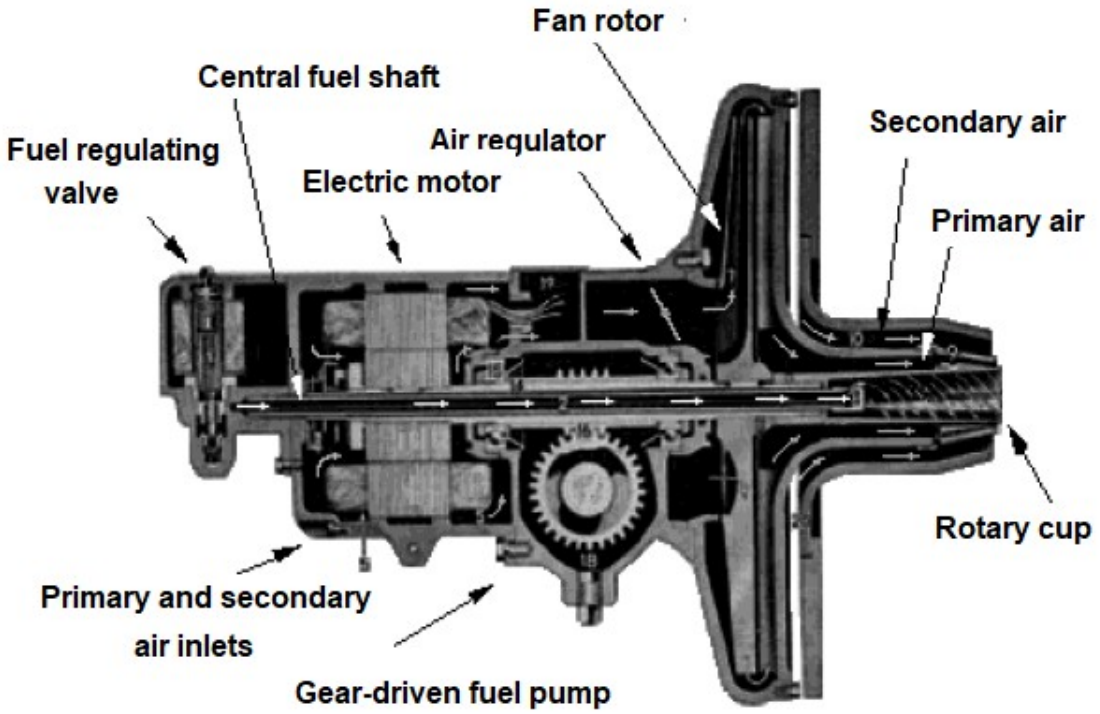
Whenever entering fuel tanks or homes, these must be properly ventilated to ensure there are no explosive mixtures of vaporized fuels with air.

If it is necessary to weld or repair a tank that has previously contained fuel, a 48-hour steam cleaning or washing process must be carried out (introducing low-pressure steam through a pipe to distribute it inside, ventilating with air, and draining the condensate from the bottom; then circulating air with a fan).

Before starting to weld, test, if possible, with an explosimeter to ensure there is no mixture of explosive gases. It is also advisable to maintain strong air circulation while welding or repairing the tank, as gases may be released when the tank's metal sheet heats up during the welding process.

Never attempt this type of work alone. Take all necessary precautions: it is a very dangerous task.

Fuel tanks must be properly designed to facilitate gas venting, annual cleaning, water purging, fuel heating, external corrosion, flooding from rain or fuel losses to the subsoil, as well as their insulation against the rigors of cold winter.



ROTARY CUP BURNER FOR LIQUID FUELS

Remember that: each burner is designed for a specific type of fuel, so you should take care to avoid mistakes when ordering fuels or be careful when mixing different fuels, as this can cause combustion problems or failures that can be significant.

The use of dual-fuel burners (liquid and gaseous fuels) requires a series of precautions, especially when switching from burning liquid fuel to gaseous fuels. This is because liquid fuels can leave behind vaporized fuel residues (which can create ignition points for the gas outside the normal flame zone, prevent the residual flame sensor from detecting them and blocking the main gas ignition, or obstruct vital areas for the combustion gas intake, preventing ignition in the appropriate area of the burner base).

steam production capacity of 15 tons/hr, 12 kg/cm², 170 PSI

This has led to very serious accidents. The most important thing in these cases is to pre-establish the checks and procedures for changing fuels, and to take the necessary time to complete them, since an unprepared maneuver without prior checks can result in an accident.

These accidents usually occur in the smoke boxes, in the detachment of the burner (hearth explosions), which affect the people who are observing the maneuver: always stand to the side when proceeding to light the burner, taking care that the covers are not in the area where you are standing if they open.